R. Whittier Comments on the 1/11/18 Red Hill Groundwater Modeling Working Group Meeting

- 1. The permeability of the saprolite is significantly underestimated The very low hydraulic conductivity of saprolite is hypothesized as limiting infiltration downward through the Red Hill Ridge and placing a low permeable barrier between the Red Hill Facility and the Halawa Shaft. The method used to measure the hydraulic appears to significantly underestimate the permeability of the geologic unit.
 - The hydraulic conductivity estimated by pneumatic testing in RHMW11 was 2.8 x 10⁻⁵ ft/d;
 - However recharge to groundwater in the Halawa Valley is about 10 inches per year.
 - This equates to an infiltration rate of 2.3×10^{-3} ft/d.
 - The water level testing in the saprolite zone of RHMW11 shows a decreasing hydraulic with increasing depth indicating downward drainage.
 - Since RHMW11 tests confirms downward drainage in the saprolite the infiltration rate of 2.3×10^{-3} ft/d becomes a lower bound for the saprolite hydraulic conductivity.
 - For the analysis of the influence the saprolite has on infiltration and groundwater flow a more realistic and defensible value for the hydraulic conductivity of this geologic formation needs to be used.
- 2. Data don't support that quarry recharge creates a barrier between the Red Hill Facility and the Halawa Shaft The Navy hypothesizes that the quarry excavations result in a high rate of recharge in the quarry depressions elevating the water table ensuring no groundwater flows from the Red Hill Facility toward the Halawa Shaft.
 - To show this in a defensible manner the Navy must demonstrate:
 - o by direct measurements that the water table elevation in the basalt aquifer is greater than that beneath the facility;
 - o by direct measurements that the infiltrate in the quarry is great enough in magnitude and spatial distribution to result in a significant elevation of the gournwater beneath the aquifer; or
 - o by a comprehensive water balance analysis that the infiltration is sufficient to produce the result they hypothesize.
- 3. It is unclear the degree of effort that went into \estimating the magnitude and direction of the lava bedding plane There is general agreement among the subject matter experts that plane of the lava bedding will have a significant influence on LNAPL travel in the vadose zone making this a critical parameter to accurately constrain.
 - The methods and data used to arrive at the tilt direction and angle need to be made available to regulators for independent review.
- 4. RHMW07 and HDMW2253-03 Water Levels Unreliable to Estimate Groundwater Gradient and Flow Direction Both wells have anomalously high water level elevations that will significantly bias the estimated groundwater gradient and flow direction.
 - Including these wells in the gradient analysis results in a groundwater gradient from the Halawa Valley to the axis of the Red Hill Ridge.
 - Excluding these wells from the gradient analysis results in a groundwater gradient from the axis of the Red Hill Ridge toward the Halawa Shaft; a much different outcome for the drinking water risk assessment.

- There issues with both wells besides the anomalously high water table elevation in the wellbore that bring into question their reliability for estimating the groundwater flow direction such as:
 - o Extremely significant drawdown in RHMW07 during low flow sampling; and
 - There is strong upward flow in HWMW2253-03 from -700 ft msl to -100 ft msl, likely causing the elevated water table elevation in this well.
- Until the issues how well the water table elevation in these two wells reflect that of the larger aquifer, these wells should not be included in the gradient analysis.
- 5. The groundwater path interpreted using the Piper Diagrams is flaw While mixing trends along a groundwater path is one of the interpretations that can be made with Piper Diagrams, any inferred trends must be supported by the physical location of the wells along the inferred flow path.
 - The OWDFMW-1 is one end member of the hypothesized groundwater mixing path, while RHMW02 and RHMW03 constitute the other end member.
 - The Navy's interpretation of the placement of the well chemistry on the Piper Diagrams does account for alteration of the groundwater chemistry by natural attenuation process;
 - Respiration of the natural attenuation microbe greatly increases the alkalinity of RHMW02 and RHMW03, shifting their plotted location to one extreme of the hypothesized mixing path.
 - Sulfate, one axis on the Piper Diagram, is almost totally absent from RHMW02, again
 placing the plotted location of this well at a spot far removed from that of the unimpacted wells.
 - The three wells that plot on the hypothesized mixing line between the two end members are not physically located between the two end members with the exception of RHMW2254-01
 - The Navy needs to explain the discrepancies noted or remove the geochemistry from those lines of evidence considered with estimating the groundwater flow path.
- 6. Groundwater Flow Around the Saprolite/Valley Fill of South Halawa Valley is not Considered It is unlikely that LNAPL could migrate in direct path from the Red Hill Facility to the Halawa Shaft due to the Valley Fill/Saprolite along that path. However, LNAPL and dissolved contaminant flow around these formations must be evaluated.
 - The water table elevation in the wells located between the USTs is about a foot higher than that at the Halawa Shaft when it is not pumping. This provides the hydraulic head differential to allow groundwater and LNAPL flow from the USTs to the Halawa Shaft.
 - The Valley Fill/Saprolite sequence extends beneath the water table preventing LNAPL migrate to the northwest (i.e. toward the Halawa Shaft) for a currently undefined distance up South Halawa Valley.
 - The operative question is whether or not the penetration of the Valley Fill/Saprolite extents far enough up the South Halawa Valley to be protective of the Halawa Shaft.